

## Heterogeneous Chip Integration for GHz Systems, Phase I

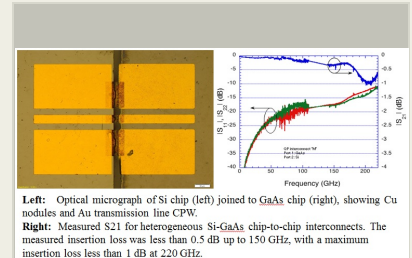
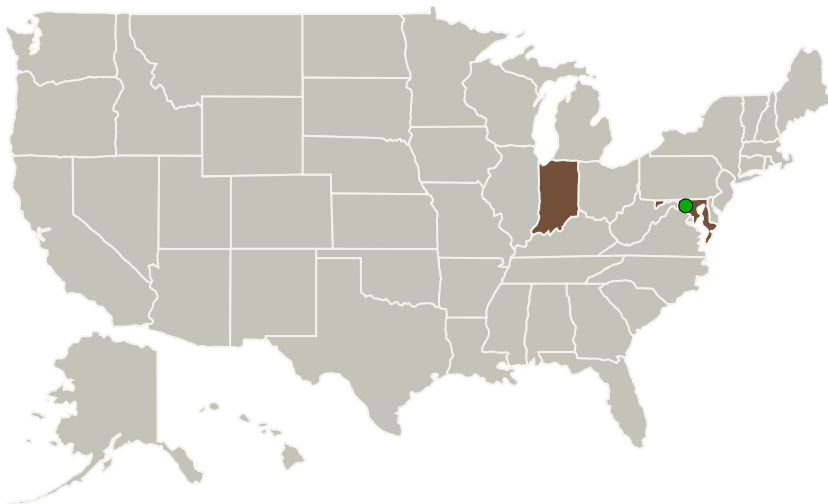
Completed Technology Project (2014 - 2014)



## Project Introduction

Indiana Integrated Circuits, LLC (IIC) proposes to develop the customizable, high-performance microchip interconnect technology called Quilt Packaging (QP) to address NASA's requirement for high performance integration of heterogeneous microwave systems. QP is an affordable, scalable, patented edge-interconnect technology for joining microchips of disparate materials and/or process technologies into monolithic-like systems that perform electrically as if they were one chip. QP enables sub-micron chip-to-chip alignment, extremely small ( $< 10$  micron) chip-to-chip gaps, and can be implemented in multiple substrate materials, including SiGe, GaAs, Si, InP, GaSb, SiC, GaN, and more. Quilt Packaging can enable extremely low-loss, wide-bandwidth integration of MMIC modules comprising disparate material systems and/or process technologies. QP has demonstrated less than 0.1 dB insertion loss up to 100 GHz, and under 1 dB out to 220 GHz. Initial reliability testing of QP chipsets have demonstrated no degradation or mechanical issues, having undergone thermal cycling from  $-40$  C to  $125$  C for over 350 cycles and counting. In addition to excellent microwave performance, QP has the potential for decreasing system size, weight and power. The proposed effort will leverage previous work in GaAs and Si QP to demonstrate a heterogeneously integrated "quilted" chipset of SiGe, GaAs and/or InP chips. Resulting data from this Phase I will directly apply to the design, fabrication and demonstration of a functioning MMIC module in Phase II. Throughout Phase I consideration will be given to NASA system needs and transition to production-level Quilt Package chip fabrication with commercialization partners Research Triangle Institute and Northrop Grumman Corp. for manufacturing scale-up of Quilt Packaging enabled MMIC modules.

## Primary U.S. Work Locations and Key Partners



## Heterogeneous Chip Integration for GHz Systems, Phase I Briefing Chart Image

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| Organizations Performing Work       | Role                    | Type        | Location            |
|-------------------------------------|-------------------------|-------------|---------------------|
| Indiana Integrated Circuits         | Lead Organization       | Industry    | South Bend, Indiana |
| ● Goddard Space Flight Center(GSFC) | Supporting Organization | NASA Center | Greenbelt, Maryland |

| Primary U.S. Work Locations |          |
|-----------------------------|----------|
| Indiana                     | Maryland |

## Project Transitions

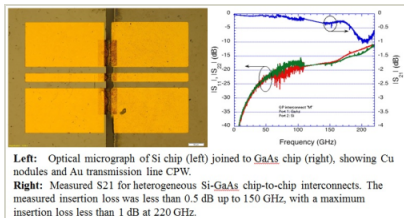
▶ **June 2014:** Project Start

✓ **December 2014:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137533>)

## Images



## Briefing Chart Image

Heterogeneous Chip Integration for GHz Systems, Phase I Briefing Chart Image  
(<https://techport.nasa.gov/image/125795>)



## Final Summary Chart Image

Heterogeneous Chip Integration for GHz Systems, Phase I Project Image  
(<https://techport.nasa.gov/image/125785>)

## Organizational Responsibility

## Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

## Lead Organization:

Indiana Integrated Circuits

## Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

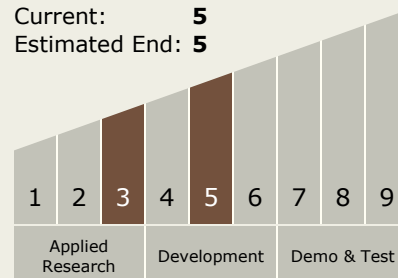
Carlos Torrez

## Principal Investigator:

Jason M Kulick

## Technology Maturity (TRL)

Start: **3**  
Current: **5**  
Estimated End: **5**



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## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System